

undergo more than one change: thus as these spicules are now composed of chalcedony and yet present the rhombohedral excavations of calcite on their surface, they must previously have been carbonate of lime; and we know from their forms that they were *originally* siliceous spicules.

Under what circumstances these alterations take place, or how they may occur, or why the mineral should be changed, must be a matter of conjecture; but that they do occur we have evidence in the case just mentioned and in the formation of all mineral pseudomorphs; so that, if the *mould* of a Lithistid in flint, such as I have mentioned, were filled up with calcite and the flint subsequently removed, the original structure, instead of being siliceous, would be calcareous, or it might be pyritic, and so on. In two parcels of powder which came from the interior of two separate flints from Wallingford, Berkshire, the Coccoliths, which abound in both, are all silicified in one, and all calcareous in the other.

Where the siliceous material of which the flints and chert are composed came from I do not pretend to say, any more than the calcareous material which formed the kunker, especially the latter, seeing that out of eight analyses the quantity of lime only amounts to a mean of about nine parts in a thousand taken from the regur in eight different places, the lowest quantity of which, in three of the instances, did not reach two parts (Medlicott and Blanford, *op. cit.* vol. i. p. 430).

It may, however, be fairly inferred that the purer material will be found in the *nodular* forms, both of flint and kunker, and the less pure in the *tabular* forms, viz. the sheet kunker and the chert respectively.

Thus have I endeavoured to correlate that which may be said to be going on at the present day with what has taken place in ages past—not that such concretionary formations are confined to kunker and flint, for all geologists know that such have been taking place in the stratified deposits from the beginning; but to comprehend all, so far as we are able, is best accomplished by studying what is taking place at the present moment for comparison with what has taken place heretofore, since this kind of induction is the least exposed to error.

XXXI.—*General Considerations upon the Carcinological Fauna of great Depths in the Caribbean Sea and Gulf of Mexico.* By ALPHONSE MILNE-EDWARDS*.

THE progress which submarine investigations have caused

* Translated from the 'Comptes Rendus,' February 21, 1881.

zoology to make exceeds any thing that could have been hoped for; and almost every day new facts are added to those already known. Those seas which had been best explored, and with regard to which naturalists thought there was nothing more to be learnt, have furnished unexpected discoveries when those zones which the fishermen do not usually reach came to be investigated.

I have already had occasion to call the attention of the Academy to the results obtained last summer on board the 'Travailleur' off the northern coast of Spain; and I dwelt especially upon the difference that exists between the animal population of the great depths and that of the surface or of the shores. When we compare their representatives it is as though we had before us two distinct faunas belonging neither to the same time nor to the same climate. The importance of this fact cannot escape any one; and geologists, in the determination of the age of a formation, must take it seriously into account. In fact, at the present day, in the same seas, there are in course of formation deposits, as to the contemporaneity of which there can be no doubt, and which contain the remains of perfectly dissimilar creatures. The animals of the littoral deposits belong to types of higher organization; those of the deeper deposits have a more ancient character: some of the latter present incontestable affinities with the fossils of the Secondary epoch; others resemble the larval condition of certain existing species.

The investigations which I have lately made of the Crustacea of the Caribbean Sea and Gulf of Mexico have furnished interesting results; and I think it worth while to say a few words about them. The materials I have had at my disposal were abundant and varied; for Mr. Alexander Agassiz had the kindness to send me for determination all the Crustacea collected by the expeditions of the U. S. navy during the years 1877, 1878, and 1879. A special ship, the 'Blake,' was fitted out for the performance of deep dredgings; and the harvests collected by her have proved most fruitful. I have now completed the examination of all the Brachyurous Decapods, of the Anomura, and the Cuirassed Macrura; I have described them in the Bulletin of the Museum of Comparative Zoology at Harvard College*; and now, treating the question from another point of view, I shall confine myself here to the indication of the general results at which I have arrived.

The number of species collected is much greater than would have been supposed from what was known of this part of the

* "Études préliminaires sur les Crustacés," par A. Milne-Edwards (1^e partie), Bull. Mus. Comp. Zool. Harv. Coll. tome viii. no. 1.

fauna ; for the groups just enumerated it amounts to 214, of which 153 are new to science. Forty of these species differed too much from the forms previously known to take their place in existing genera, and I have been compelled to regard them as the types of new generic divisions. This variety of species is the more remarkable when we consider that fifty years ago the existence in these same regions of scarcely a score of Crustacea had been indicated.

Certain groups, supposed to be foreign to the American seas, are, on the contrary, extraordinarily abundant at these great depths. Such is the family Galatheidæ, of which I have recognized forty-one species of very varied forms, and which I have had to distribute into eight different genera. Some of these have representatives in nearly all seas, such as *Galathea* and *Munida**. The others have never been met with elsewhere. Among these I may indicate the *Galacantha*, the carapace of which is armed above and on the sides with large sabre-shaped spines ; the *Galathodes*, of which the eyes are very small, with imperfect corneola ; the *Orophorhynchi*, in which the eye-peduncles are greatly reduced, spinous, and capable of concealing themselves in part beneath the rostrum ; the *Elasmonoti*, with a carapace destitute of teeth or spines ; the *Diptychi*, in which the abdomen is twice folded upon itself and concealed beneath the sternum ; and, lastly, the *Ptychogastres*, which greatly resemble the preceding, but have the legs of unusual length.

The true Crabs, or Brachyurous Decapods, do not inhabit the very great depths of the Caribbean Sea. They abound on the shores ; numerous species, but generally of small size, are found down to 500 metres below the surface ; beyond this they seem to disappear. Nevertheless at 800 metres a crab with a square carapace, which I have described under the name of *Bathyplax*, was captured, representing in these seas the *Gonoplax* of our shores ; but its eyes are atrophied and destitute of corneola, its orbits are rudimentary, and it is blind. On the other hand, the Anomurous and Macrurous Crustacea swarm at great depths. Down to 3500 metres there have been found representatives of the genus *Willemoesia*, those singular Macrura which almost exactly reproduce the forms of the Eryonidæ of the Jurassic period, but are blind, while the eyes of the above fossil Crustaceans appear to have attained their ordinary development. From a bottom of more than 4000 metres the dredge brought up some Galatheidæ of very remarkable forms, which I have placed in the new genus *Galathodes*.

* I have described two species of *Galathea* and eleven of *Munida*.

What is especially astonishing is the infinite variety of zoological forms, which often renders it almost impossible to apply the classifications which have hitherto been regarded as most firmly established. In fact, transition types abound, and we find numerous intermediate forms between groups that we were accustomed to consider very distinct. Of this I will give some examples.

The family Paguridæ, or the Hermit-Crabs, arranged by zoologists of most authority in the group Anomura, hitherto included only species which, although very numerous, were all very similar to each other, and without any direct connexion with the Macrura. The American dredgings have furnished unexpected forms, which unite the Hermit-Crabs with the Thalassinidæ. Such is *Pylocheles Agassizii*, the abdomen of which, instead of being soft and unsymmetrical like that of the *Paguri*, is composed of firm regular rings and terminated by a symmetrical fin. This Crustacean lives in holes, the entrance of which it closes with its claws, which, when they are united by their inner margin, constitute a very perfect operculum. The *Mixtopaguri* differ less from the *Paguri*; for their abdomen, which is more developed on the right than on the left side, is divided into seven distinct and movable joints, the first five of which are imperfectly calcified, while the last are large and hardened. In the *Ostraconoti* the carapace is entirely coriaceous, and the abdomen so reduced that the female, to hold her eggs, makes use of the legs of the fourth pair, the penultimate joint of which, widened into a palette, forms a sort of floor underneath the packet of eggs. The *Catapaguri* establish a passage between the preceding and the *Spiropaguri*: their abdomen is still very small, but twisted and lodged in little shells, the dimensions of which contrast strongly with the size of the carapace and legs, which remain outside. In some of these Crustaceans we also observe curious adaptations to a special mode of life. Thus *Eupagurus discoidalis*, inhabiting the tubular shell of the *Dentalia*, makes use of one of its chelæ as a circular operculum perfectly moulded to the orifice of the dwelling which it has to close. The *Xylopaguri* also merit our attention: they have never been found except in holes hollowed in fragments of wood; and whether it be a reed, a rush, or some branch, these cavities are always open at both ends; and the animal does not introduce itself backwards, as the ordinary *Paguri* do, but penetrates into its lodging directly. When there the chelæ always make their appearance at one of the orifices, the other being closed by the extremity of the abdomen, converted into an opercular buckler.

The family Dromiidae, hitherto so distinct from the Homolidae, is now united therewith by the genus *Homolodromia*, the legs of which also resemble those of *Dorippe*. The *Acanthodromiæ* are intermediate between the *Dromiæ* and the *Dynomeneæ*; they have the buccal pieces, the eyes, and the antennæ of the former, and the ambulatory feet of the second. The *Dicranodromiæ* have the carapace narrower than that of the ordinary *Dromiæ*; its form resembles that of certain fossil Crustaceans of the secondary formations, of which the genus *Ogydromites* has been formed; the legs are very long, like those of the *Homolæ*. In *Homolopsis* also the body is more rounded and narrower than that of the last-named Crustacea; and in this respect they approach the Dromiidae; but their eyes are nearly atrophied. The *Homolæ* are represented by two species, one of which appears to me to differ in no respect from *H. spinifrons*, hitherto found only in the Mediterranean. This is a fresh example of the immense geographical distribution attained by certain animals of the great depths. *Cymopolia*, of which one species also inhabits the Mediterranean, possesses eight in the Caribbean Sea. Some of them approximate to *Dorippe* by the intermediation of *Cyclodorippe* and *Cymonomus*; and these last-mentioned crustaceans, which are perfectly blind, have, on the other hand, close affinities with the *Ethuseæ*. The genus *Ethusa*, supposed to be confined to the Mediterranean, must also be recorded among those of the American seas; among the Crustacea from the Florida reefs I have recognized a species and described it under the name of *E. americana*, only differing from *E. mascarone* by characters of but little importance.

The examples just cited suffice to give an idea of the interest attaching to the study of the animals from great depths. These bathymetrical researches are only commencing; and when we compare the small extent over which the dredge has been dragged with the immense spaces which have never been touched, when we reflect upon the manifold causes which render the retreats of certain animals still inaccessible to our means of investigation, we cannot avoid the conviction that the results obtained are only a very small part of those in reserve for us in the future. Hence we cannot too forcibly direct the attention of scientific men in all countries to the utility of coordinating their efforts and undertaking methodical investigations in the seas to which they have the most easy access.

Our zoological groupings now present so many gaps that it is impossible to understand the general plan which has presided over the grouping of living creatures. Palæonto-

logical discoveries on the one hand, and on the other those which are promised to us by submarine explorations, will gradually fill up these gaps, and perhaps one day enable naturalists to grasp the relations which exist between the different animals.

Our country has not remained indifferent to these researches; the Academy at its last meeting heard the interesting details given by M. de Lacaze-Duthiers upon the organization of his laboratory at Roscoff and the work that has been accomplished there. For my own part I am happy to be able to announce that the expedition accomplished last year in the Bay of Biscay by the 'Travailleur' will not be the last of its kind, and that this summer the same ship will undertake a series of dredgings in the Mediterranean, of which I shall have the honour to give you an account.

XXXII.—*On a Collection of Nocturnal Lepidoptera from the Hawaiian Islands.* By ARTHUR G. BUTLER, F.L.S., F.Z.S., &c.

THE collection of which the following is an account consists of eighty specimens forwarded to me last year by the Rev. Thomas Blackburn. It is particularly interesting as being to a large extent composed of Micro-Lepidoptera, of which we have hitherto received very few species from the Hawaiian Islands.

Sphingidæ.

1. *Deilephila calida*, sp. n.

General size, form, and pattern of *D. euphorbie*, but the primaries coloured as in *D. biguttata* of Madagascar, and the secondaries differing from all species of the genus in their dark outer border; on the under surface the general coloration is bright brick-red. Primaries above smoky grey; a broad dark olive-brown belt across the base, three unequal subcostal spots, and a tapering discal belt of the usual form and also of a dark olive-brown colour; a narrow transverse fasciole forking from the inner margin of the discal belt to the costa; below this fork the belt is edged internally by a golden ochreous line; outer borders of a dark and slightly purplish-grey colour, decidedly darker than the central area of the wing; fringe with a slender whitish basal line: secondaries black, with narrow diffused sooty-grey border, scarcely paler